

WILLIMANTIC LINEN COMPANY: MILL NO. 2
(American Thread Company: Mill No. 2)
South of Main Street opposite Duham Street,
north bank of Willimantic River
Windham
Windham County
Connecticut

HAER No. CT-44-C

HAER
CONN
8-WIND,
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Mid-Atlantic Region
National Park Service
Department of the Interior
Philadelphia, Pennsylvania 19106

HAER
CONN
8-WIND,
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HISTORIC AMERICAN ENGINEERING RECORD

WILLIMANTIC LINEN COMPANY: MILL NO. 2
(American Thread Company: Mill No. 2)

HAER No. CT-44-C

Location: South of Main Street opposite Dunham Street, north bank of Willimantic River, Borough of Willimantic, Windham, Windham County, Connecticut

USGS Quadrangle: Willimantic, Connecticut
UTM Coordinates: 18.732600.4621240

Date(s) of Construction: 1862-64; later modifications included replacement of two turbines c1915-17 and one generator c1940

Present Owner: ATC Partnership
14 Farwell Street
West Haven, CT 06579

Present Occupant: Willimantic Power Corporation
257 East 200 South Suite 800
Salt Lake City, UT 84111

Present Use: Vacant except for powerhouse, in which Willimantic Power Corporation operates new hydroelectric facilities.

Significance: Mill No. 2 was the biggest structure built by the Willimantic Linen Company, the most important employer in Willimantic c1855-1985. Located at the firm's largest water privilege, the mill included at least two generations of turbines with horizontal-shaft installations, the first of which may represent an early example of such installations.

Project Information: The Willimantic Linen Company/American Thread Company complex is eligible for inclusion on the National Register of Historic Places. Willimantic Power Corporation installed new hydroelectric facilities in Mill No. 2 in 1988-90. Changes made to the facilities extant in 1988 included: rebuilding the central intake gate and sealing the outer two intake gates; removal of the central turbine; dredging of the tailrace; and repair of the southern tailrace wall. In compliance with Federal Energy Regulatory Commission Article 21 and a request from the Connecticut Historical Commission, Willimantic Power Corporation documented the hydropower facilities extant in 1988 prior to project construction.

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Part I: HISTORICAL INFORMATION*

Willimantic Linen Company began operations in 1854 using cotton mills built in 1825, and soon shifted from linen to thread production when the Crimean War interrupted European flax supplies. By 1895, the firm built three new mills, a bleachery and dye house, a storehouse, an office, and other auxiliary structures. American Thread Company purchased Willimantic Linen in 1898 and continued to expand the Willimantic complex until c1915, adding or completing two mill buildings, a second dye house, and a warehouse. Thread manufacture persisted here until 1984. Many of the buildings survive, awaiting proposed redevelopment (Figure 2). This documentation focuses on hydropower development associated with Mill No. 2. For summaries of the history and significance of this complex, see Weaver 1869, Anonymous 1974, Roth et al. 1981, and Harlow 1988.

Information on 19th-century Willimantic Linen hydropower facilities is limited, but the overall sequence of development can be inferred from several sources (Gray 1869; Porter 1885; Mueller 1897; Associated Mutual Insurance Company 1908; Sanborn Map Company 1924; Anonymous 1974; personal communications, Laura Knott Twine). Between 1854 and 1864, the company purchased or developed four consecutive water privileges on the Willimantic River, which falls about ninety feet through the Borough of Willimantic over a ledge-dominated two-mile distance (Figure 1). Of the four privileges, totalling some 63 feet of fall, the lowermost had 16.5 feet of fall at a framed timber dam built c1825 in conjunction with a frame cotton mill on the north side of the river. Willimantic Linen bought this site in 1854, along with an 1825 stone cotton mill on the north bank between the two uppermost privileges (the "Spool Shop," at or just above the site of the c1915 warehouse shown on Figure 2). The firm began operations in the older mills, and immediately began construction of Mill No. 1 and related hydropower facilities. Willimantic Linen built two dams c1854, above and below the Spool Shop, perhaps replacing or improving an earlier dam in the process. The uppermost dam (the "Spool Dam") was a mortared granite-block structure about 500 feet upriver from Mill No. 1, and developed a water privilege with 13.6 feet of fall (Figure 2). The second 1854 dam, a framed timber structure (later encased in granite block) built at the downstream end of Mill No. 1, provided 11 feet of head (Porter 1885: 26). Willimantic Linen developed its last water privilege c1862-64, building a mortared granite-block dam with 22 feet of fall for Mill No. 2 (Figure 2).

The surviving configuration of narrow intake arches in Mill No. 2's wheel-house, in an ell over the river, suggests that this installation originally had three turbines. Material evidence described below indicates that by the late 19th century, three 36-inch single-runner horizontal-shaft turbines were installed here by the Swain Turbine and Manufacturing Company of Lowell, MA. A late-19th-century Swain catalog asserted that a 36-inch wheel (runner) with 22 feet of head would generate 167.23 hp (Swain Turbine and Manufacturing Co. 1897: 10). The three wheels in Mill No. 2 would thus have been expected to generate about 500 hp, a figure exactly matching the reported situation here

* Capitalized citations refer to photographs included with this documentation.

c1880 (Porter 1885: 26). It is therefore possible that the three horizontal-shaft Swain turbines were in place by this date. Installation of the Swain turbines required raising the arches over the turbine bays, as indicated by evidence of arch alteration and the re-use in place of the Swain pressure cases and draft tubes, which survived in 1988 (VIEW SOUTHWEST OF TURBINE BAYS AND DRAFT TUBES; see Part II below). There was, then, apparently an undocumented, earlier set of turbines here c1864-80, probably set far closer to the tailwater elevation than the Swain installation. In this wheelhouse, built just above granitic ledge, the Swain horizontal-shaft arrangement was only possible with high draft tubes. It is thus likely that the original installation of c1864-80 involved vertical-shaft turbines.

Lowell mechanic Asa M. Swain (1830-1908) began commercial turbine production c1860, making important modifications of an earlier generation of inward-flow Francis-type turbines used at the great textile-making city. Swain was perhaps the earliest developer of the mixed-flow turbine which as a type dominated American industrial hydropower installations c1870-1915. With fewer, axially-deeper, more curved runner blades, and decreased runner diameters, mixed-flow turbines had greater efficiency than American turbines of c1848-60, and functioned better in low-flow situations. Many firms emerged with stock-size turbines of this durable and relatively inexpensive type. Swain's firm was one of a few in this era to make some horizontal-shaft installations, which were unusual prior to the growth of small-scale hydroelectric generation, beginning c1890, despite the decrease or absence of expensive bevel gearing made possible by such arrangements. The survival of one of these machines here appears to represent a relatively rare and early example of horizontal-shaft installation in New England (Hunter 1979: 347-49, 359-65, 381-83).

Although the transmission of power from the Swain turbines in Mill No. 2 is not documented, Willimantic Linen Company made very early use of electric lighting in some of its production areas beginning in 1878, and it is possible that the Swain turbines in Mill No. 2 drove electric generators prior to the replacement of these units (Weaver 1969; Harlow 1988). Water power alone was insufficient for Mill No. 2 production demands by c1880, however, when steam power was constantly required for auxiliary use (Porter 1885: 26). By the early 20th century, steam provided most of the power at the American Thread complex, with a boiler house just upstream from Mill No. 2 powering engines in another part of the mill (Associated Mutual Insurance Company 1908). The wheelhouse provided at least some of the electricity used for lighting well into the 20th century. American Thread replaced the headgates c1902, and two of the three Swain turbines c1915-17 with somewhat more efficient, probably stock-order turbines of the same size made by the S. Morgan Smith Company of York, PA, and deactivated the remaining Swain unit (American Thread Company 1902). Each Smith turbine, installed in the Swain pressure cases and draft tubes, developed about 289 hp at 185 rpm. The original generator equipment used with the Smith turbines is not documented, and was replaced c1940, probably after damage suffered in the 1938 hurricane (S. Morgan Smith Co. 1920, n.d.; personal communications, Richard G. Mackowiack). There were no later known modifications to wheelhouse installations, which were typical of early 20th-century hydroelectric facilities prior to the development of vertically-arrayed turbine-generators after c1915 (Hunter 1979: 381-83).

Part II: DESCRIPTIVE INFORMATION

This section describes hydroelectric facilities associated with Mill No. 2 as they appeared in 1988, the major components of which were headgates at a granite-block dam, three turbines and a motor-generator installation beneath a riverside wing or ell in the mill, and a tailrace. This site usually has about 22 feet of head (Figure 3).

Willimantic Linen Company built Mill No. 2 as a random-course granite, gable-roofed, 4-1/2-story structure about 70 feet wide and, after several additions, 460 feet long, with a central stair tower and three round windows in each gable end (Figure 3; GENERAL VIEW TO NORTH). Stone for the dam and mill were quarried from the river (Anonymous 1974; Roth *et al.* 1981: 261-2). The wheelhouse is a space beneath the first floor of a 3-1/2-story riverside ell which also included machine and carpenter shops. This space is about 71.5 by 50.25 feet in area and 25 feet high, over granite ledge (Figures 4-6; VIEW SOUTHWEST OF TAILRACE...; DETAIL VIEW NORTH OF WHEELHOUSE WING AND HEADGATES). There are three 9-by-6.3-foot wooden headgates with partly intact metal rack-and-pinion operating mechanisms; original trash racks did not survive (Figures 7-8; DETAIL VIEW SOUTH OF SOUTH-MOST HEADGATE OPERATING MECHANISM...). The gates controlled flow into three arched, granite ashlar, 10-foot-long turbine intakes running through a bulkhead on the southwest wall of the powerhouse. Each 8-by-4.5 foot intake has a 2-foot-high arch above (Figures 5 and 9).

Three bays, running northwest-southeast, divide the wheelhouse. The two easternmost of these bays, divided by a 34-foot arch repeated at the tailrace opening, have several levels of wooden platforms suspended from the floor above or supported by cast-iron columns resting on ledge below. The central bay contains pulley wheels and belts transmitting power from the turbines to the generator. Three turbine bays transect the westernmost wheelhouse bay, which also includes the generator. The turbine bays were originally coursed granite ashlar with low arches, built for earlier, as-yet undocumented turbine installations c1864-80. The existing facilities include later brick-and-granite arches over these bays, raised above the original arches (Figures 4-6; VIEW SOUTHWEST OF TURBINE BAYS AND DRAFT TUBES).

Three 36-inch, single runner horizontal shaft turbines occupied the turbine bays, representing two generations of installation. The northernmost turbine is the oldest, a cylinder-gate unit installed by Swain Turbine & Manufacturing Company in the late 19th century. This unit was in poor condition. There was a 16.5-by-6-inch iron plate identifying this firm near the riveted steel draft tube, which along with the steel pressure case was identical to those of the middle and southernmost turbines. The plate proclaimed:

BUILT BY
THE
SWAIN TURBINE & MFG. CO.
LOWELL, MASS.

The other two turbines, made by the S. Morgan Smith Company, were each approximately 285-hp, 185-rpm units with 18-inch-high wicket gates. Six-inch diameter steel shafts, running about 22 feet from the southernmost turbine and about 18 feet from the middle turbine, once turned 6- and 7-foot diameter (respectively) cast-iron pulley wheels. These components remained in place, but were inoperable. A 6-foot-diameter wooden wheel, identical in size to the 6-foot-wheel found in place, rested against the riverside wall of the wheelhouse in two halves, and may represent part of the Swain installation. Disarticulated leather belts 18-19 inches wide, with 52 and 38 foot shaft centers, drove a 15-kw, 120-A, 125-v General Electric D.C. motor-exciter (model 51A50) and a 500-kw, 525-KVA, 360-rpm, 600 V G.E. steel-framed generator in the northwest corner of the wheelhouse. The generator was probably purchased used from the Winslow Bros. firm in Norwood, MA after the 1938 hurricane (Figures 5-6; VIEW SOUTHWEST OF TURBINE BAYS AND DRAFT TUBES; VIEW NORTHWEST OF TRANSMISSION MECHANISMS...; DETAIL VIEW SOUTHWEST OF SOUTH TURBINE DRAFT TUBE AND SHAFT; DETAIL VIEW NORTHEAST OF SOUTH TURBINE SHAFT AND PULLEY WHEEL; DETAIL VIEW WEST OF MIDDLE TURBINE DRAFT TUBE, SHAFT, AND PULLEY WHEEL; DETAIL VIEW NORTH AND WEST OF GENERATOR...; DETAIL VIEW WEST OF MIDDLE TURBINE PRESSURE CASE...; DETAIL VIEW NORTH OF MIDDLE TURBINE WICKET GATES; personal communications, Richard G. Mackowiak).

The 38-to-40-foot-wide tailrace had an intact granite rubble south wall, 6 to 12 feet high, and a partly collapsed, 24-foot-high, granite and concrete north wall; the concrete represented previous repairs (VIEW SOUTHWEST OF TAILRACE...).

Part III: SOURCES OF INFORMATION

Historic Drawings and Photographs

The Windham Textile and History Museum, which began operations in September 1989, has obtained the surviving drawings of the American Thread Company and about 300 historic photographs. These materials are at present uncatalogued and essentially unavailable; a small number of drawings identified by Summit Hydropower c1984-87 are listed below. For future access to these materials, which will be catalogued over the next several years, contact the museum at 157 Union Street - Main Street, Willimantic, CT 06226, telephone 203/456-2178.

Interviews

Laura Knott Twine, Executive Director, Windham Textile and History Museum, provided information on site history.

Richard G. Mackowiak, Summit Hydropower, provided detailed measurements and descriptions of many hydropower facility components, plus information collected from Allis-Chalmers Corporation and General Electric Company.

William E. Worthington, Jr., Museum Specialist, National Museum of American History, Division of Engineering & Industry, provided information of the Swain and S.M. Smith turbine-making firms.

Bibliography

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Plan and diagram on file, Windham Textile and History Museum.

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S. Morgan Smith Company

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Allis-Chalmers Corporation, Hydro-Turbine Division, Box 712,
York, PA 17405, telephone 717/792-3511.

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1920 Smith Hydraulic Turbines... Bulletin No. 112. Catalogue in possession of Richard G. Mackowiak, Woodstock, CT.

Swain Turbine & Manufacturing Company

1897 Manufacturers of the Swain Turbine Water Wheels, mill gearing, shafting, pulleys, etc. Catalogue, on file, National Museum of American Industry, Division of Engineering and Industry, Washington, DC, 20560, telephone 202/357-2228.

Weaver, Glenn

1969 The Hartford Electric Light Company. Hartford: Hartford Electric Light Company.

Sources Not Yet Investigated

Surviving written records of the Willimantic Linen Company and the American Thread Company are very limited. Plans, drawings, and photographs dating to c1855 will eventually be available at the Windham Textile and History Museum, and may have additional historic waterpower details.

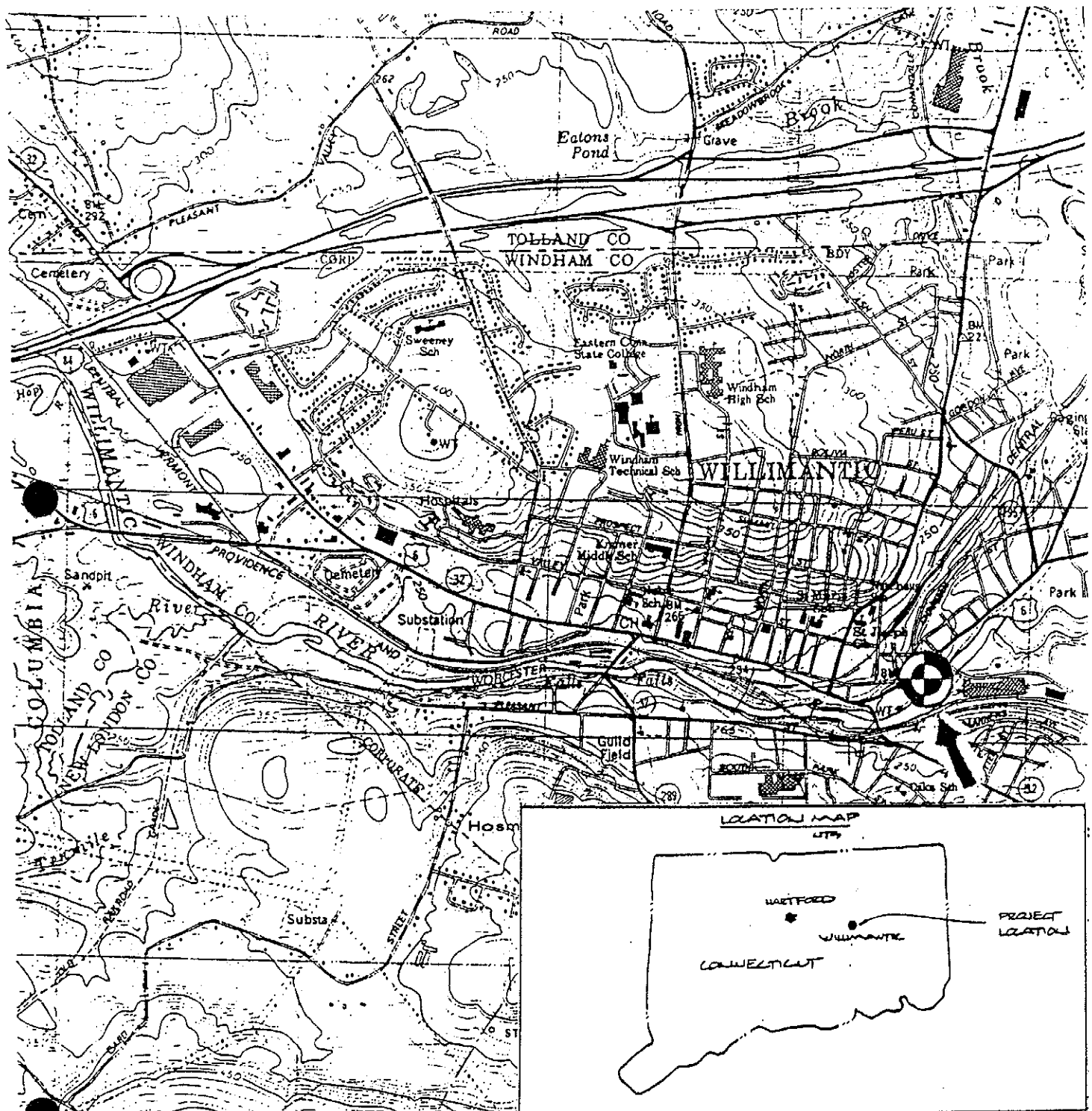


Figure 1. LOCATION OF MILL NO. 2

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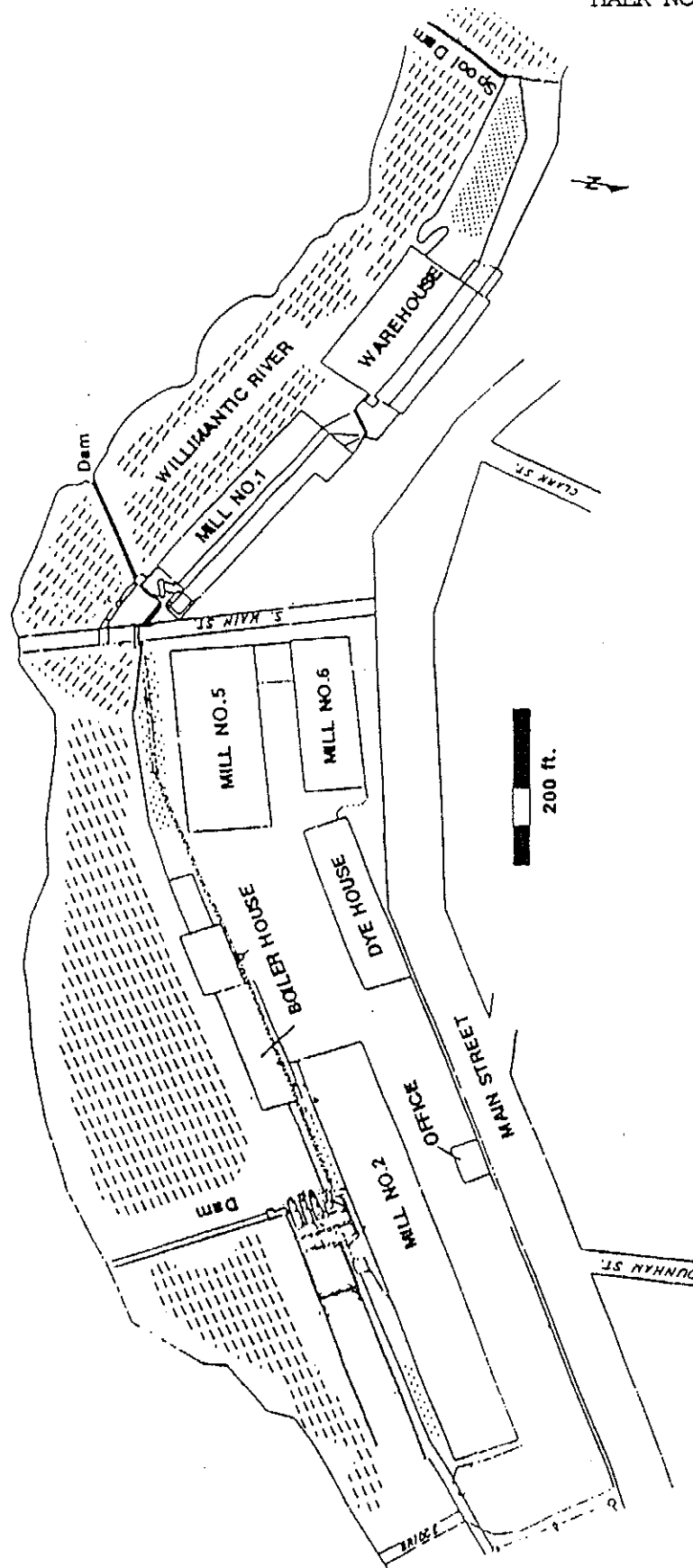


Figure 2. PRINCIPAL SURVIVING COMPONENTS, AMERICAN THREAD COMPANY COMPLEX, WILLIMANTIC, CT

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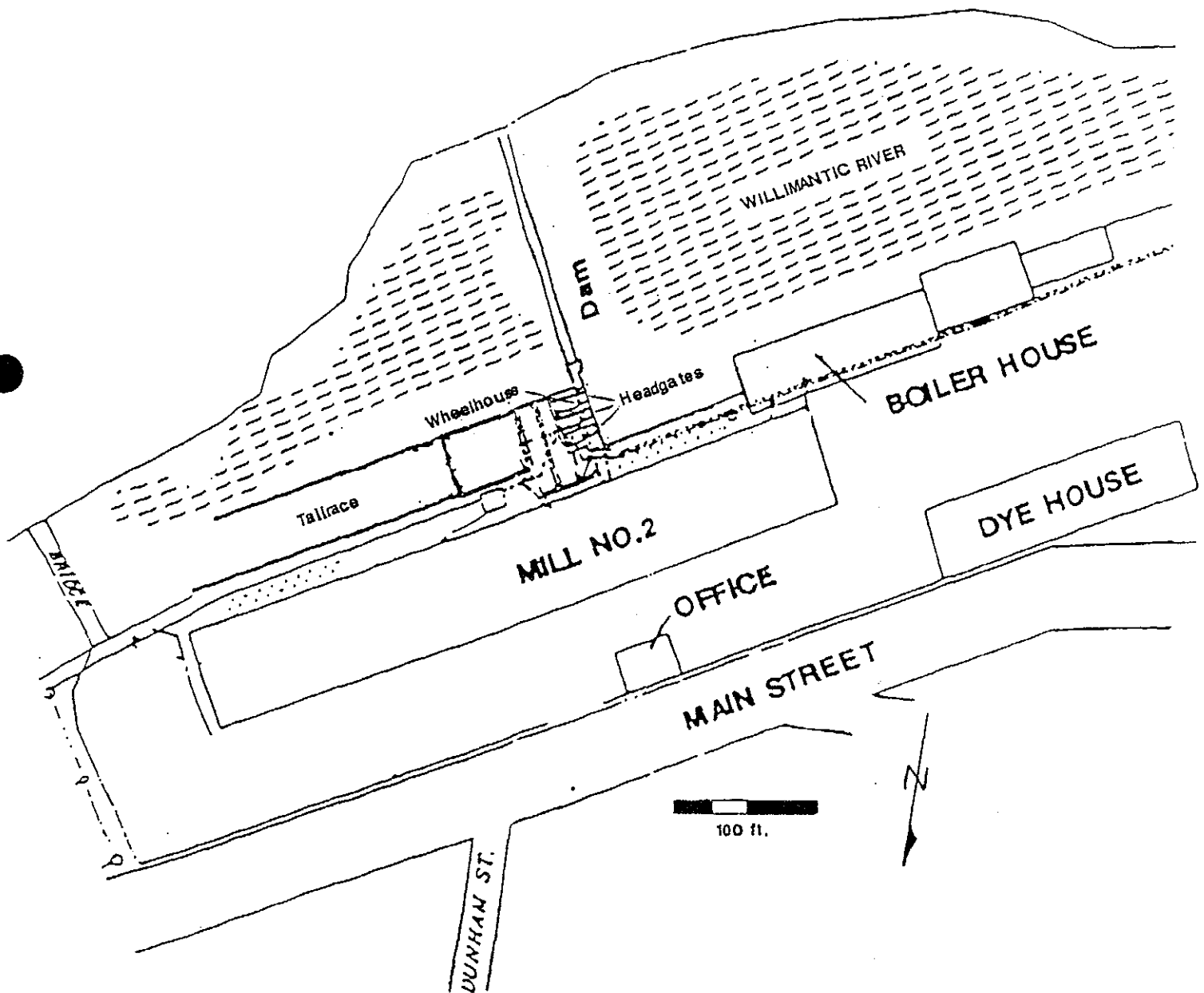


Figure 3. HYDROPOWER FACILITIES ASSOCIATED WITH MILL NO. 2

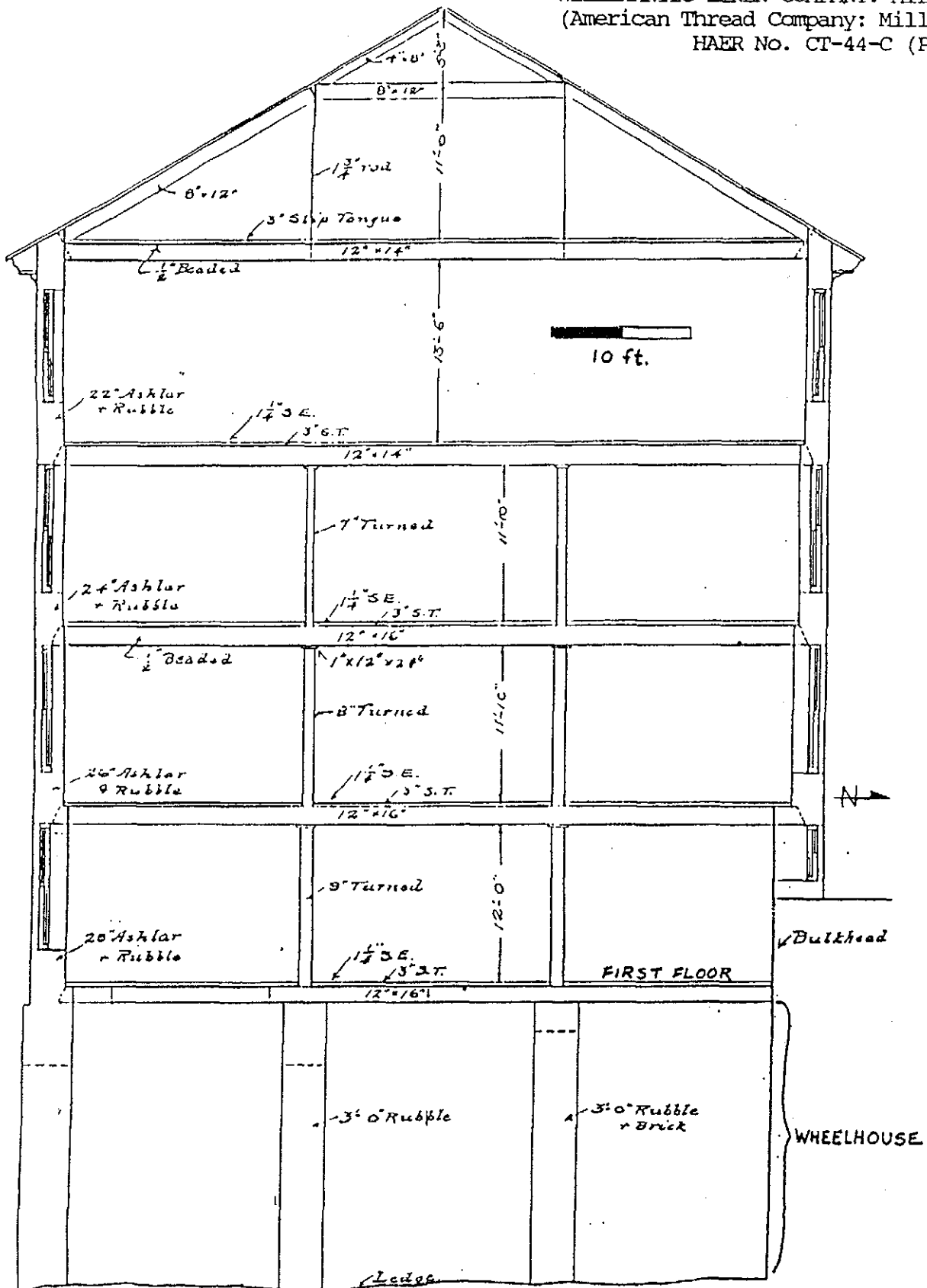


Figure 4. NORTH-SOUTH SECTION OF ELL INCLUDING WHEELHOUSE
 Source: American Thread Company 1926-40

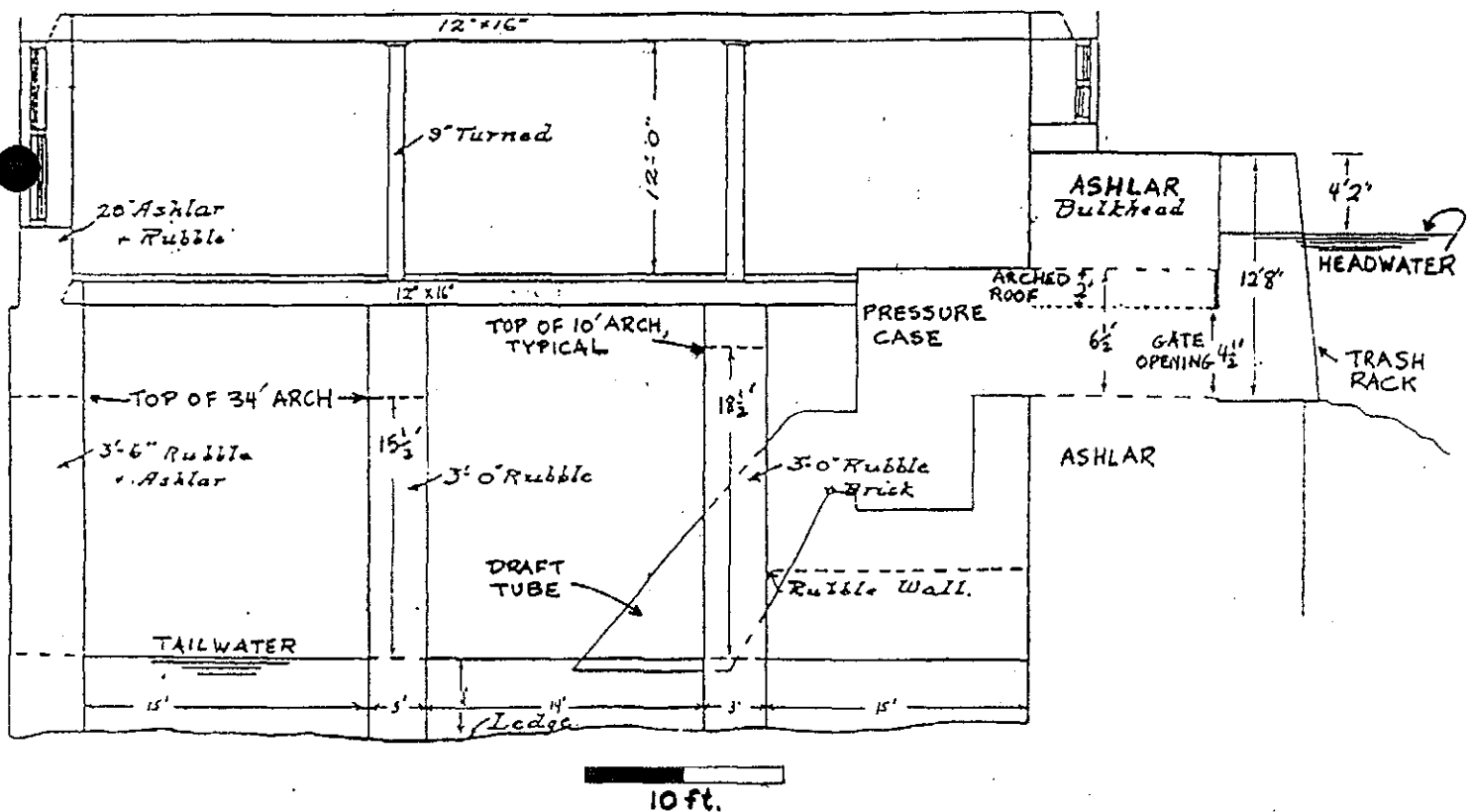


Figure 5. EAST-WEST SECTION THROUGH WHEELHOUSE
 Source: American Thread Company 1926-40

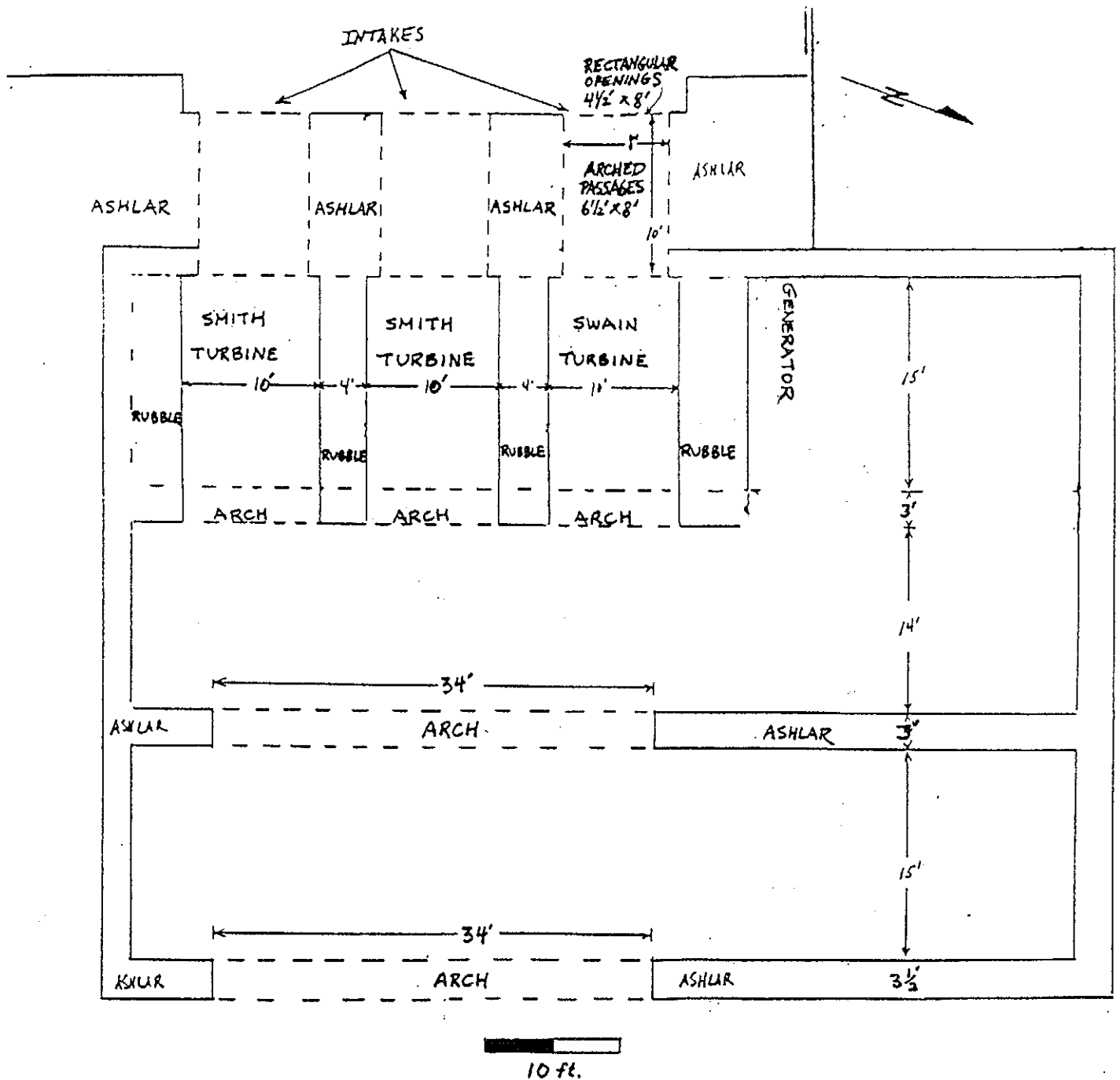


Figure 6. PLAN OF WHEELHOUSE
 Source: Sketch made by Summit Hydropower, Woodstock, CT

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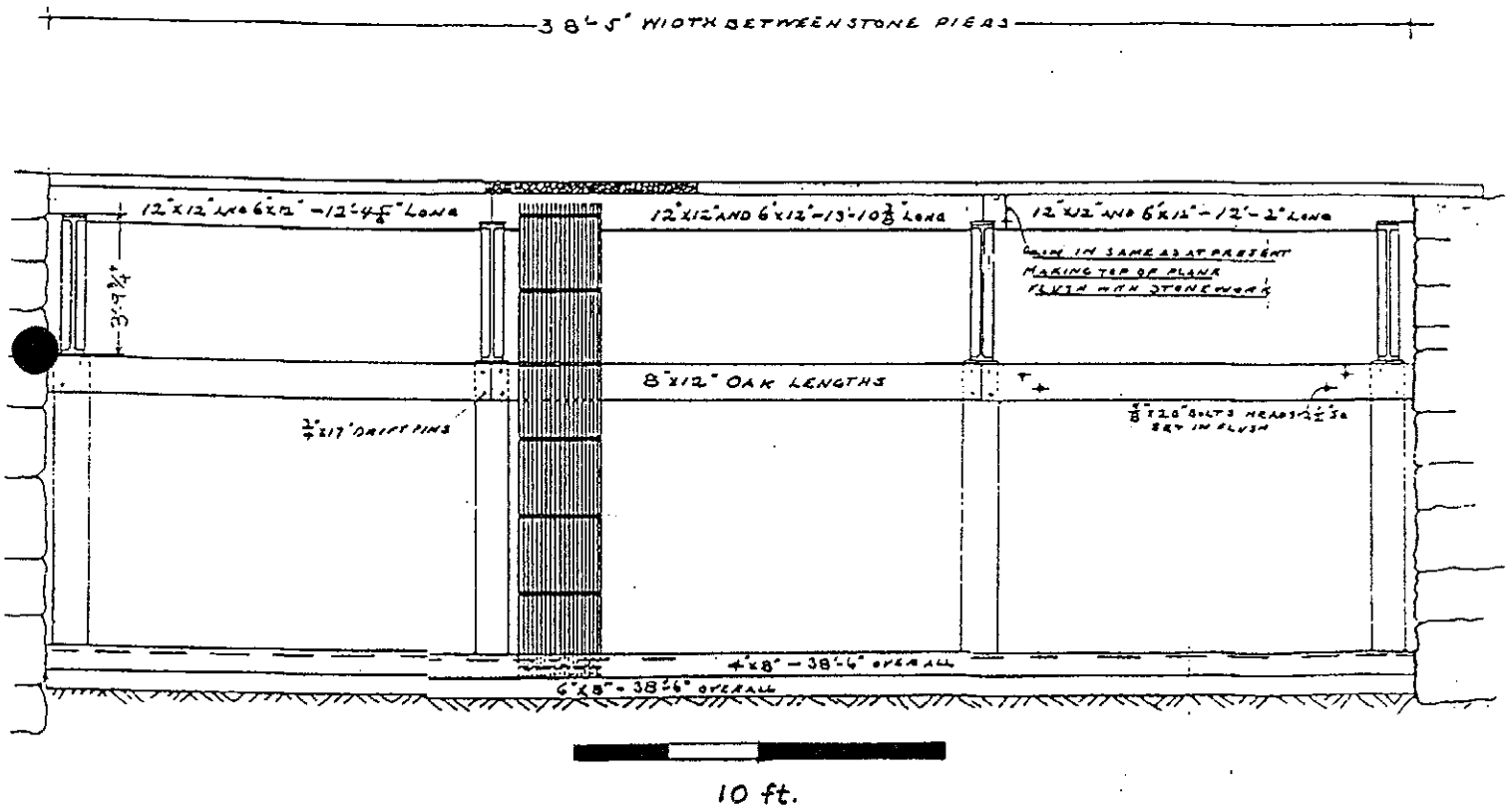


Figure 7. ELEVATION OF HEADGATES AT MILL NO. 2
 Source: American Thread Company 1902

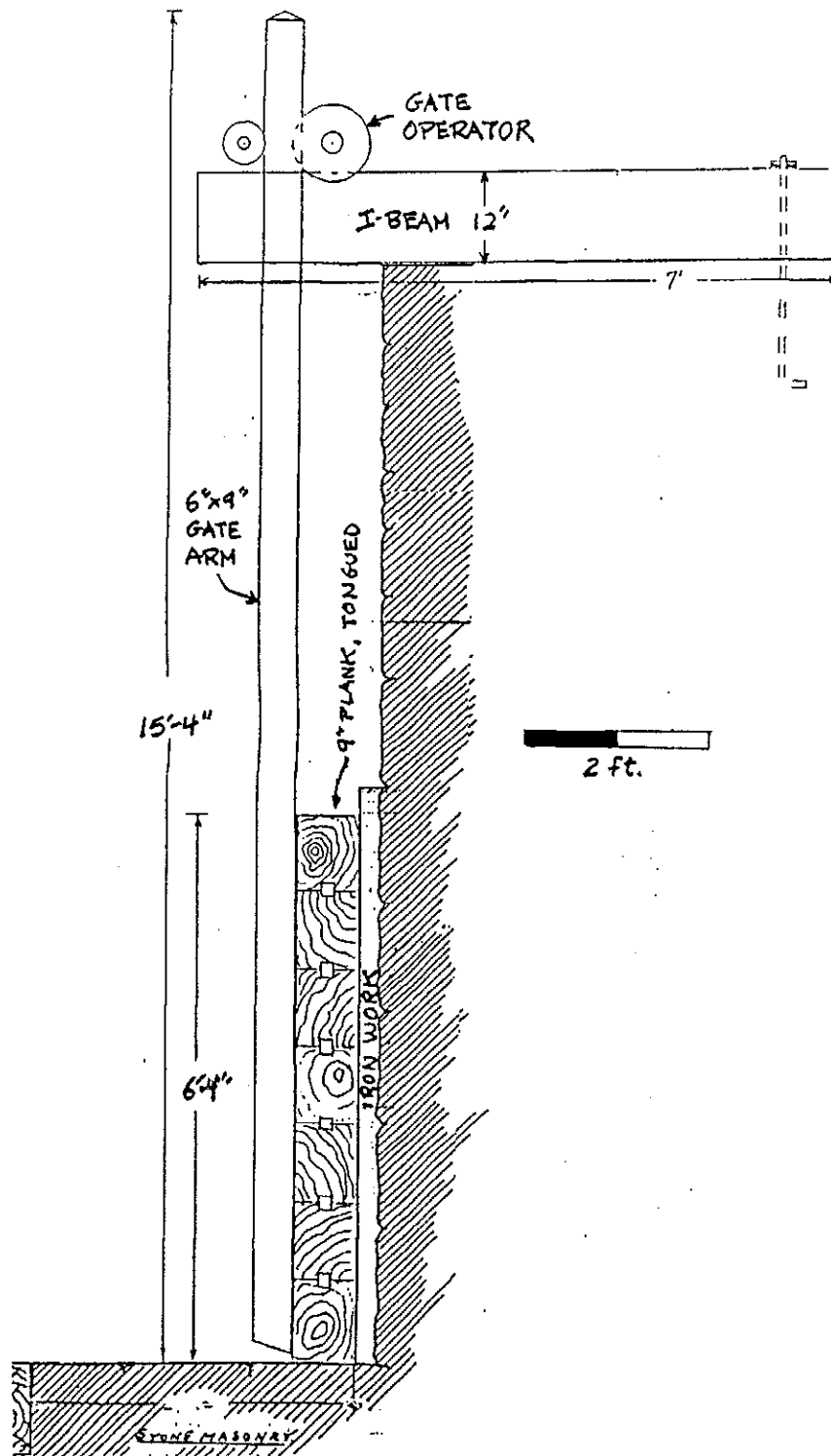


Figure 8. SECTION OF HEADGATE
Source: American Thread Company 1902

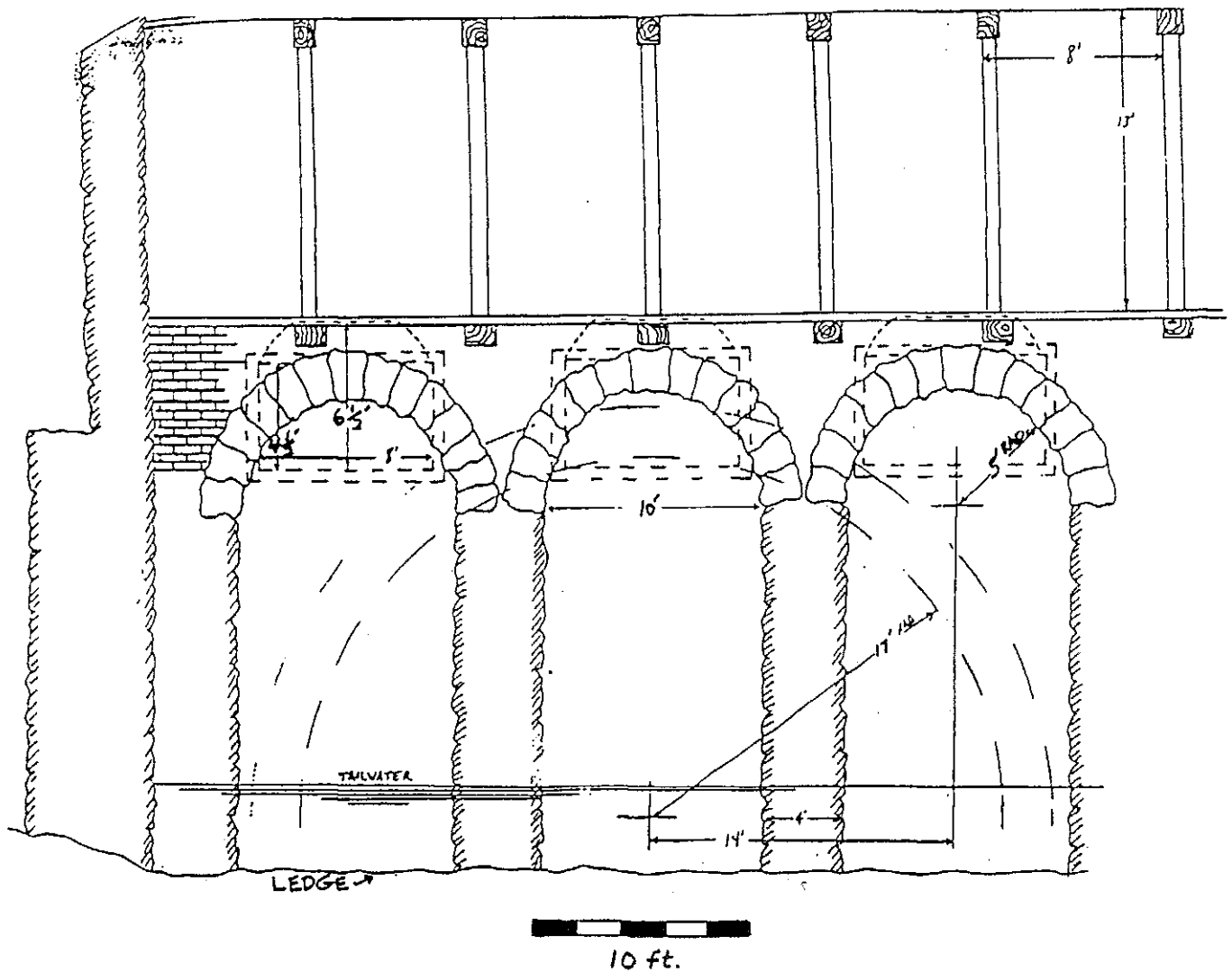


Figure 9. NORTH-SOUTH SECTION THROUGH WHEELHOUSE SHOWING ARCHES & INTAKES
 Source: American Thread Company 1900